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NATIONAL DAM SAFETY PROGRAM. LAKE KILLARNEY (MO 30012), LOWER M--ETC(U)
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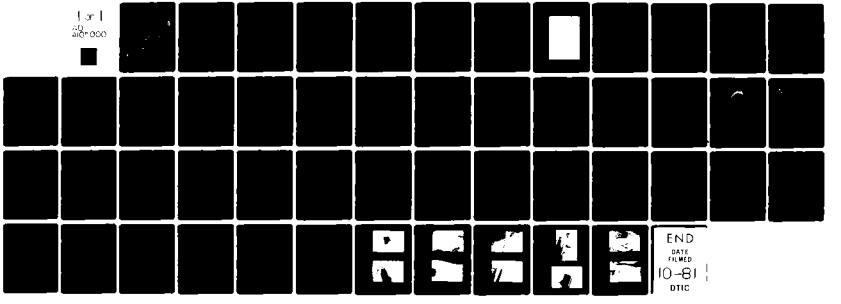

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IRON COUNTY, MISSOURI

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PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

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AUGUST 1979

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7. AUTHOR(s) L. Robert Kimball and Associates	8. CONTRACT OR GRANT NUMBER(s) DACW43-79-C-0034
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
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19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)* Dam Safety, Lake, Dam Inspection, Private Dams	
20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)* This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.	

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411059

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Lake Killarney Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of Lake Killarney Dam (MO 30012).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District because of deterioration of the concrete including cracking and honeycombing in conjunction with the lack of information concerning the condition of the upstream face of the dam and possible undermining at the toe of the dam. Complete evaluation of the structure with respect to the visible structural deficiencies is not possible without further investigation.

SUBMITTED BY: SIGNED
Chief, Engineering Division
21 SEP 1979
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer
21 SEP 1979
Date

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LAKE KILLARNEY DAM

IRON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30012

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY

L. ROBERT KIMBALL AND ASSOCIATES
CONSULTING ENGINEERS AND ARCHITECTS
EBENSBURG, PENNSYLVANIA

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

AUGUST 1979

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

NAME OF DAM	Lake Killarney Dam
STATE LOCATED	Missouri
COUNTY LOCATED	Iron
STREAM	Stouts Creek
DATE OF INSPECTION	1 May 1979

Lake Killarney Dam was inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of federal and state agen cies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Based on the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. The dam is in the intermediate size classification since the impoundment is greater than 1000 acre-feet but less than 50,000 acre-feet. The downstream affected area includes the Arcadia Valley Bible Camp (1 dwelling, 2 meeting halls and several other buildings) located 0.4 miles downstream and a dwelling located 0.7 miles downstream of Lake Killarney Dam. The Spillway Design Flood is the PMF (Probable Maximum Flood). The PMF is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonable possible in the region.

Because of the configuration of the dam with a total overflow spillway section, the spillway capacity is dependent on the structural stability of the dam. The 10-year storm corresponds to an overtopping of approximately 3.7 feet. Continued deterioration of the structure with time may reduce the structural stability of the dam and thus the spillway capacity.

Deficiencies noted at Lake Killarney Dam included the unknown right abutment contact, the degree of arching is unknown, poor quality of the masonry which includes honeycombing, seepage and vegetation on the downstream slope, possible undermining of the downstream toe, unobserved conditions of the upstream face and dam/foundation contact, unknown details of the repairs to the dam failure. These deficiencies should receive prompt action. These deficiencies should be remedied at the direction of a professional engineer knowledgeable in concrete dams. In addition, a warning system and a formal inspection program should be initiated.

It is recommended that the owner take prompt action to correct the deficiencies described.

R. JEFFREY KIMBALL, P.E.
L. Robert Kimball & Associates
Vice President, Earth Sciences

JAMES T. HOCKENSMITH
L. Robert Kimball & Associates
Geologist

KUANG HWEI CHUANG, P.E.
L. Robert Kimball & Associates
Hydraulic Engineer

Lake Killarney - Overview

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE KILLARNEY DAM - ID NO. 30012

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Lake Killarney Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based on available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) Lake Killarney Dam is a concrete gravity arch dam. The dam is 425 feet long and 35 feet high above the rock foundation. The dam radius is 280 feet. The upstream face is vertical. The downstream slope is 1H:3V. The dam conforms more to a rubble masonry type structure than a concrete structure. The top width is 4 feet. The base thickness of the dam is approximately 16 feet. The dam is founded on granite. The dam acts as a total overflow section thus the spillway length is approximately 400 feet.

Outlet works consist of two 36" cast iron pipes at elevation 798. In addition, two 16" cast iron pipes are located at elevation 795 (top of dam elevation 808).

b. Location. Lake Killarney is located 3.5 miles east of Ironton, Missouri on Stouts Creek. The dam can be located (Section 1, Township 33 North, Range 4 East) on the Lake Killarney 7.5 minute U.S.G.S. quadrangle.

c. Size Classification. Lake Killarney Dam is an intermediate size structure (35 feet high, 1180 acre-feet).

d. Hazard Classification. Lake Killarney Dam is a high hazard dam. Downstream conditions indicate that loss of life is probable should failure of the dam occur.

e. Ownership. Lake Killarney Dam is owned by Killarney Shores. Correspondence should be addressed to:

Killarney Shores
Jess Hickman
Route 69
Ironton, Missouri 63650
314-546-3245

f. Purpose of Dam. Lake Killarney Dam is used for recreation.

g. Design and Construction History. Lake Killarney was located and the general design concept developed by Henry Muskopf. Design details were developed by Smith & Dickson. The dam was constructed in 1911 by Merle B. McCarthy Construction Company. Smith & Dickson had a full time inspector, Walter Kendell, as resident inspector during the construction of the dam. The concrete for the dam was made at the job site by using unwashed creek gravel. Some steel in the form of abandoned mine rails was used in the dam. The toe portion of the dam was constructed approximately five years after the original dam was constructed. Correspondence from Mr. Kendell indicates that the dam leaked immediately after completion, particularly on the south portion of the dam (near right abutment).

In 1943, a report was made by W.J. Knight and Company indicating that the dam was in deplorable condition. Mr. Knight indicated that the concrete was deteriorating very rapidly. Mr. Knight recommended that all the voids in the dam be filled with concrete. Mr. Knight noted that the toe constructed five years after the dam was almost totally disintegrated, except along the south one-third of the dam.

On May 9, 1949, a court suit was filed by various residents in the area of Lake Killarney against the owners of Lake Killarney to make repairs to the dam. This action was initiated because of a hole which had developed in the dam. The hole was leaking 20,160 gallons per minute. Mr. Kendell, who was resident engineer during construction, reported that very good plans and specifications were available, but that the contractor paid no attention to them. Mr. Kendell reports that he remembers men working in waist deep water shoveling gravel out of the foundations. The concrete for the dam was then placed in this knee deep water. In a report prepared for this court case, it was recommended that sand bags be used to repair the dam. The report states that a minimum of 500 sand bags be obtained and placed to stop the leak. It is not known what method was used to stop the leak.

h. Normal Operating Procedures. No operating records exist. The outlet works have not been operated for many years. Excess inflow into the reservoir discharges over the spillway crest.

1.3 PERTINENT DATA

a. Drainage Area. 50 square miles (U.S.G.S. quadrangle)

b. Discharge at Damsite (cfs).

(1)	Maximum known flood at dam site	Unknown
(2)	Spillway capacity	Limited by structural stability only
(3)	Drainlines	Unknown
(4)	During inspection	Estimated 110

c. Elevation (feet). - Based on spillway crest (elevation 808) estimated on U.S.G.S. quadrangle.

(1)	Top of dam	808.0
(2)	Spillway crest	808.0
(3)	Normal pool	808.0
(4)	Maximum pool (PMF)	831.6
(5)	Invert on 36" cast iron pipes	798.0
(6)	Invert on 16" cast iron pipes	795.0
(7)	Tailwater at day of inspection	779.0

d. Reservoir (feet).

(1)	Length of maximum pool	11,000
(2)	Length of normal pool	9,000

e. Storage (acre-feet).

(1)	Top of dam	1180
(2)	Spillway crest	1180
(3)	Normal pool	1180
(4)	Maximum pool (PMF)	3684

f. Reservoir Surface (acres).

(1)	Top of dam	60
(2)	Spillway crest	60
(3)	Normal pool	60
(4)	Maximum pool (PMF)	150

g. Dam.

(1)	Type	Concrete gravity arch
(2)	Length	425 feet
(3)	Height	35 feet
(4)	Top width	4 feet

(5)	Side slopes - upstream	Vertical
	downstream	1H:3V
(6)	Zoning	None
(7)	Grout curtain	None

h. Spillway.

(1)	Type	Uncontrolled
(2)	Length	400 feet
(3)	Crest elevation	808.0
(4)	Upstream channel	Lake
(5)	Downstream channel	Stouts Creek
(6)	Weir shape	Broad crested weir

i. Drawdown Facilities.

(1)	Type	Two 36" CI pipes and two 16" CI pipes
(2)	Elevation - 36" pipes	798.0
	- 16" pipes	795.0
(3)	Length	Approximately 7 feet each

SECTION 2 - ENGINEERING DATA

2.1 DESIGN. No design drawings, reports or data are known to exist.

2.2 CONSTRUCTION. The report by W.J. Knight and Company in 1943 and a report prepared for the court order in 1949 both give descriptions by Walter Kendell, the resident engineer during construction of the dam. The only information available on the dam is contained in these reports.

2.3 OPERATION. No operating records exist.

2.4 EVALUATION.

a. Availability. The only engineering data available is contained in the two reports stated in 2.2 above.

b. Adequacy. The field surveys and visual inspections presented herein are considered adequate to support the conclusion of this report. Seepage, stability, and stress analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" are not on record. This is a deficiency which should be rectified.

c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. The onsite inspection of Lake Killarney Dam was conducted by personnel of L. Robert Kimball and Associates on May 1, 1979. The inspection consisted of:

1. Visual inspection of the retaining structure, abutments and toe.
2. Examination of the spillway facilities, exposed portions of any outlet works, and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.

b. Project Geology. Lake Killarney is underlain by bedrock consisting of the Cambrian aged Elvins Group and Bonneterre Formation. The Elvins Group is further subdivided into the Derby-Doerun Formation, a dolomite, and the Davis Formation, which is a glauconitic shale with fine grained sandstone, limestone and dolomite. The Bonneterre Formation consists of dolomite, dolomite limestone and limestone. The dam, however, is underlain by bedrock consisting of Precabmrian aged rhyolite. It may be glonconitic in the lower part. The only structural feature in the vicinity of Lake Killarney is the Ironton Fault, the southernmost extension of which is believed to be about 2 or 3 miles west of the lake. The Ironton Fault has not yet been fully substantiated, but is thought to extend for over ten miles in a northwest-southeast direction. The fault displacement and type (normal or reverse fault) are unknown.

Jointing is also to be expected in the rocks in this area since they are present in nearly all competent rocks in the state. The degree of jointing at Lake Killarney is unknown.

c. Dam and Spillway. Visual inspection of the dam indicated the structure was in very poor condition. The concrete in the dam is of very poor quality. The concrete is extensively honeycombed with considerable seepage passing through the dam. Much of the dam has vegetation and trees growing on the downstream slope. It is reported by Walter Kendall, resident inspector during construction, that the concrete was in very poor condition and the dam leaked immediately after construction. The crest of the dam is also in poor condition. Flow over the dam is confined to several areas which are lower than other portions of the crest. Some portions of the crest are broken and are missing. Viewing the downstream face of the dam shows that the concrete was poured in very distinct layers. These layers resemble cross-bedding as shown in some sandstones. The abutments are founded on rhyolite. It is not known whether the right abutment is keyed into bedrock or soil. Thus, the degree or arching is unknown.

In addition, flow over the crest near the right abutment has eroded a portion of the right abutment. The high lake level obscured visual examination of the upstream face of the dam. In addition, the downstream toe could not be viewed because of tailwater. It must be noted however, that the report prepared in 1943 noted that the toe was severely undercut and was non-existent in the north two-thirds of the dam. During the inspection, approximately one-third of the way from the south abutment, the dam was undercut approximately 4 feet deep above the tailwater level.

d. Drain Lines. Two 36" and two 16" pipes are present through the dam to act as drain lines. No valves were noted on these drain lines. The condition of the pipes is unknown.

e. Reservoir Area. No pertinent problems were noted in the reservoir area. The watershed is moderately steep and wooded.

f. Downstream Channel. Discharges from the spillway enter Stouts Creek. Stouts Creek enters the Little St. Francis River several miles downstream of the dam.

3.2 EVALUATION. Visual inspection revealed the dam to be in very poor condition. The concrete in the crest has deteriorated significantly. A large amount of seepage is exiting through the concrete and vegetation is present on the downstream face. The downstream toe of the dam may be undermined to a large extent. The right abutment should be investigated to determine if arch action can be transmitted to the abutment.

Complete evaluation of the structure cannot be made without a detailed stability analysis or stress analysis with test results of the concrete and complete mapping of the cracks and geometry of the section. In addition, the upstream face should be examined with the pool level drawn down and the downstream toe area examined below the tailwater.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES. The reservoir is maintained at the spillway crest at all times. The reservoir has not been drawn down for many years.

4.2 MAINTENANCE OF DAM. No maintenance of the dam is conducted.

4.3 MAINTENANCE OF OPERATING FACILITIES. The operating facilities are not maintained.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT. There is no warning system in effect.

4.5 EVALUATION. Maintenance of the dam and operating facilities are considered poor. There is no warning system in effect to warn downstream residences of large spillway discharges or failure of the dam.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. There is no hydraulic and hydrologic design data available.

b. Experience Data. The drainage area was developed using the U.S.G.S. quadrangle sheet. The lake surface area was determined by planimetering the quadrangle sheet. Surface area - elevations were determined by planimetering various contour lines within the drainage area on the U.S.G.S. quadrangle sheets. The spillway and dam layout was made from surveys conducted during the inspection.

c. Visual Observations. The dam acts as a total overflow section. The spillway is 400 feet long. Normal discharge is carried over several portions of the crest which are approximately 2 inches lower than the remainder of the crest. The crest of the dam has deteriorated significantly. The inspection team felt that high flows over the crest might cause sever erosion or loss of a portion of the crest. In addition, high flows might cause severe erosion on the right abutment.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway.

The Corps of Engineers, St. Louis District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydraulic Engineering Center (HEC) U.S. Army Corp of Engineers, Davis California, July, 1978. The major methodologics or key input data for this program are discussed in Appendix B.

To enable us to complete the hydraulic and hydrologic analysis for this structure, it was necessary to make the following assumptions:

1. Water level prior to flood was at the spillway or top of dam (elevation 808.0).

2. Upstream reservoirs were neglected because of their small size, limited storage capability (Shepard Mountain Dam) and distance from Lake Killarney.

Complete summary sheets of the computer output are presented in Appendix B. To facilitate review, the major results of the overtopping analysis are presented below:

Peak Inflow	155,324 cfs
Spillway Capacity	Based on Structural Stability

Ratio of PMF	Maximum Reservoir Water Surface	Maximum Depth over Dam, ft.	Maximum Outflow, cfs.
.10	813.06	5.06	15389
.20	816.06	8.06	30878
.30	818.57	10.57	46372
.40	820.80	12.80	61860
.50	822.86	14.86	77332
1.00	831.58	23.58	154522

The Corps of Engineers spillway Design Flood for a high hazard-intermediate dam is the PMF. Because of the configuration of the dam with a total overflow section, the spillway capacity is related to the structural stability of the dam. The spillway capacity cannot be assessed without further studies.

For reasons outlined in Section 6, the structural stability of the dam is questionable, particularly during periods of high discharges and flooding.

In addition to the PMF routing, the 10 year storm was routed through the reservoir. The 10 year storm routing indicated that the dam would be overtopped by 3.66 feet (9,462 cfs). With high water levels, the dam might fail from sliding, overstressing of the masonry, shearing or erosion of the right abutment.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations revealed the dam to be in very poor condition. The poor condition of the concrete, honeycombing and seepage through the dam is of concern. The foundation rock appears to be competent, but the characteristics of the foundation/concrete contact is suspect particularly in view of the fact that it is reported that the foundation was excavated and the concrete poured in waist deep water. The toe area was undercut above tailwater approximately 1/3 of the way from the right abutment. Any undercutting below the tailwater was unobserved.

b. Design and Construction Data. Very little design or construction data is available on the dam other than the descriptions made by Mr. Walter Kendell in the reports of 1943 and 1949. No testing of concrete was performed. The report in 1949 states that with 6 feet of water over the top of dam, the resultant pressure point rises to a point 11.11 feet below the top of dam and the overturning forces greatly exceed the stabilizing forces. Stability, stress and seepage analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" are not on record, which is a deficiency.

c. Operating Records. No operating records are kept on the structure.

d. Post Construction Changes. Approximately 5 years after the original construction the toe was added. In 1943, it was noted that two-thirds of this toe had almost entirely disintegrated. In 1949, a hole developed in the dam which was large enough to pass 20,160 gpm. This hole was repaired by placing sandbags in the hole and on the upstream face.

e. Seismic Stability. The dam is located in seismic zone 2, to which the guidelines assign a "moderate" earthquake potential. No seismic stability analysis has been conducted.

SECTION 7 - ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. The visual observations, review of available data, hydrologic calculations, and past operational performance indicate that Lake Killarney is in very poor condition. The ability of the dam to pass the 10-year storm and the PMF without failure of the dam is dependent on the structural stability of the dam which cannot be evaluated at this time. Continued deterioration of the structure with time may reduce the structural stability of the dam and thus the spillway capacity.

The dam was designed as a concrete gravity arch, however, the degree of arching action at the right abutment is unknown. Extensive honeycombing, seepage and deterioration of concrete exists. The long term effect of the deterioration and weakening of the concrete is unknown and cannot be determined without more extensive work. The reservoir should be drawn down to examine the upstream face and the tailwater should be drawn down to view to toe area for undercutting. The right abutment should be repaired. Stability, stress and seepage analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" are not on record, which is a deficiency. Prompt action should be taken to make repairs and further evaluate the dam.

b. Adequacy of Information. Complete assessment of the structure cannot be made because of the unknown condition of the toe and upstream face, the limited design data, construction data and no stability, stress or seepage analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams".

c. Urgency. The deficiencies described herein are serious and corrective actions listed below should be initiated promptly.

d. Need for Phase II. In order to accomplish some of the recommendations/remedial measures outlined below, further investigations will be required.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. The reservoir level should be drawn down to examine the condition of the concrete on the upstream face. The tailwater should be drawn down to examine the condition of the downstream face, particulary any undercutting.

b. Core borings should be performed to determine the condition and strength of the concrete. The borings should be carried into the foundation rock to examine the concrete/foundation contact. The concrete obtained from the core borings should be tested.

c. All pipe gates should be exercised and lubricated at regular intervals.

d. A detailed stability, stress and seepage analysis should be performed on the structure comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" and conducted by a professional engineer knowledgeable in the design of concrete dams.

e. Institute a formal warning system to warn downstream residents of high spillway discharges or failure of the dam.

APPENDIX A

DRAWINGS

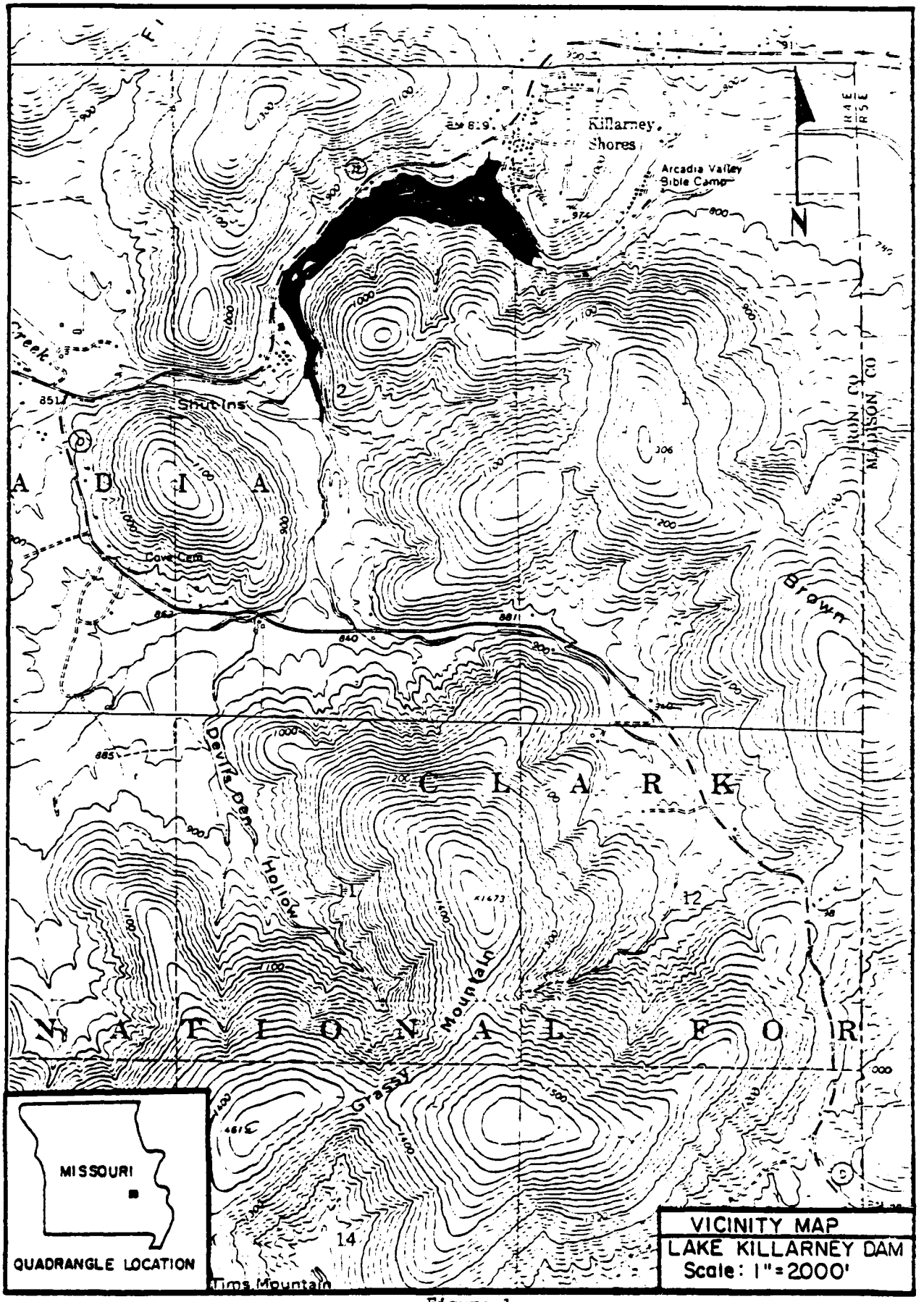
Killarney Shores
Arcadia Valley Bible Camp
Shut Ins
Cave Cem
Brown
Devils Den Hollow
Grassy Mountain
Tims Mountain
MADISON CO
IRON CO
A D I A
C L A R K
N A T I O N A L F O R
MISSOURI
QUADRANGLE LOCATION
VICINITY MAP
LAKE KILLARNEY DAM
Scale: 1" = 2000'

Figure 1

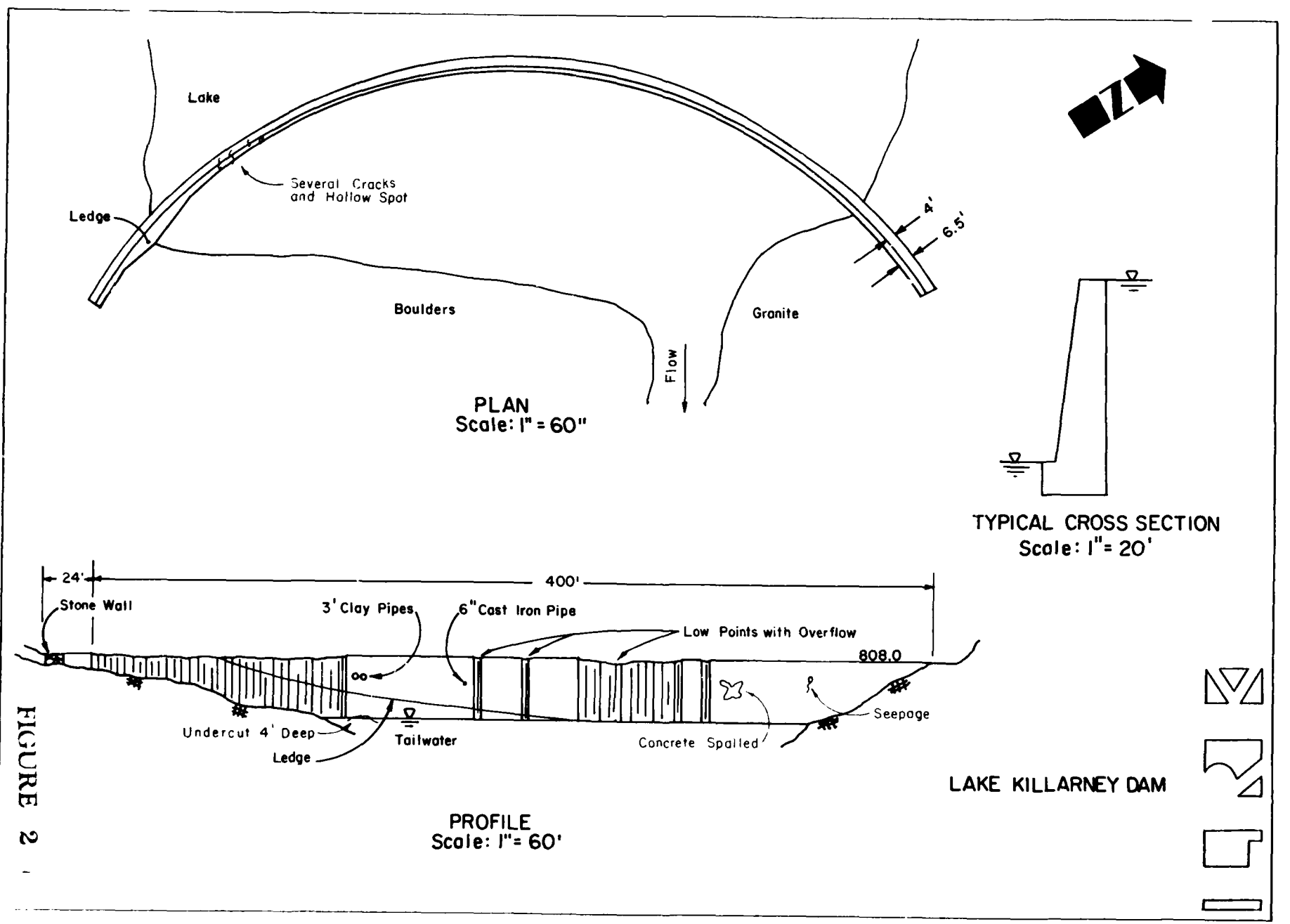
Lake
Several Cracks and Hollow Spot
Ledge
Boulders
Granite
Flow
4'
6.5'
PLAN
Scale: 1" = 60"
TYPICAL CROSS SECTION
Scale: 1" = 20'
24'
400'
Stone Wall
3' Clay Pipes
6" Cast Iron Pipe
Low Points with Overflow
808.0
Undercut 4' Deep
Ledge
Tailwater
Concrete Spalled
Seepage
PROFILE
Scale: 1" = 60'
LAKE KILLARNEY DAM

FIGURE 2

APPENDIX B

HYDROLOGY AND HYDRAULICS

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for a reservoir routing. The Probable Maximum Precipitation is derived and determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors have not been applied. A 48 hour storm duration is assumed with total depth distributed over 6 hour periods in accordance with procedures outlined in EM 1110-2-1411 (SPF Determination). The maximum 6 hour rainfall period is then distributed to hourly increments by the same criteria. Within-the-hour distribution is based upon NOAA Technical Memorandum NWS HYDRO-35. The non-peak 6 hour rainfall periods are distributed uniformly. All distributed values are arranged in a critical sequence by the SPF criteria. The final inflow hydrograph is produced by deduction of infiltration losses appropriate to the soil, land use, and antecedent moisture conditions.

The reservoir routing is accomplished by using Modified Puls routing techniques wherein the flood hydrograph is routed through lake storage. Hydraulic capacities of the outlet works, spillways, and crest of dam are used as outlet controls in the routing. Storage in the pool area is defined by an elevation-storage capacity curve. The hydraulic capacity of the outlet works, spillways, and top of dam are defined by elevation-discharge curves.

Dam overtopping analysis has been conducted by hydrologic methods for this dam and lake. This computation determines the percentage of the PMF hydrograph that the reservoir can contain without the dam being overtopped. An output summary in the hydrologic appendix displays this information as well as other characteristics of the simulated dam overtopping.

The above analysis has been accomplished for this report using the systemized computer program HEC-1 (Dam Safety Version), July, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The numeric parameters estimated for this site are listed in the computer printout. Definitions of these variables are contained in the "User's Manual" for the computer program.

The inflow hydrograph was routed through the reservoir using HEC-1's Modified Puls option.

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME LAKE KEARNEY
I.D. NUMBER 3002
SHEET NO. 1 OF 3
BY CTM DATE 6-15-77

LAKE KEARNEY

DRAINAGE AREA

AREA = 50 MI² (ST. LOUIS DISTRICT CORPS OF ENGR. AND U.S.G.S. TOPOGRAPHIC QUAD)

UNIT HYDROGRAPH PARAMETERS

KOCH METHOD:

t_c = 3.5 HRS. (FROM TIME OF CONCENTRATION NOMOGRAPH, KENTUCKY BUREAU OF HIGHWAYS)

= 0.668
= 2.0125

WHERE LENGTH = 17,500 FEET

CURVE NUMBER METHOD

$$\text{LAG (L)} = \frac{L^{0.8}(S+1)^{0.7}}{1900\,Y^{0.5}} = \frac{(6500)^{0.8}(3.10)^{0.7}}{1900\,(5)^{0.5}}$$

$$= \frac{(6910)(1.90)}{4249} = \underline{3.1 \text{ HRS}}$$

WHERE L = GREATEST FLOW LENGTH IN FEET
$S = \frac{1000}{CN} - 10$ AND CN = CURVE NUMBER
Y = SLOPE IN %

LOSS RATE AND BASE FLOW

STRTL = 1 INCH
CNSTL = 84 SCS CURVE NUMBER
STRTQ = 1.5 CFS/MI²
QRCSN = 0.05 (5% OF PEAK FLOW)
RTIOR = 2.5

UTILIZED ANTECEDENT MOISTURE CONDITION III

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME LANE MCCARNEY
I.D. NUMBER 302-2
SHEET NO. 2 OF 3
BY DTW DATE 6-.5-79

PROBABLE MAXIMUM STORM

FROM H.R. NO. 33

2 HOUR INCH RAINFALL (SQUARE MILE)
R_6 = 82% R_{12} = 100% R_{24} = [illegible]

ELEVATION - AREA - CAPACITY RELATIONSHIP

SPILLWAY CREST ELEV. 808, AREA = 60 ACRES
INITIAL STORAGE 170 AC-FT
(FROM PHASE I INSPECTION DATA AND
U.S.G.S. 7.5-MIN. QUAD)

ELEV. 820, AREA = 105 AC.
ELEV. 840, AREA = 175 AC.

FROM CONIC METHOD FOR RESERVOIR VOLUME,
FLOOD HYDROGRAPH PACKAGE (HEC-1, DAM
SAFETY VERSION USERS MANUAL),

$H = 3V/A = 3(170)/60 = 8.5'$ ∴ 808 - 8.5 = 799.5

ELEV. (FT.)	799	808	812	815	820	840
AREA (AC)	0	60	80	90	105	175

SPILLWAY DISCHARGE

DETERMINED BY HEC-1,

SPILLWAY CREST AT ELEV. 808'
LENGTH = 400'
COEFFICIENT OF DISCHARGE = 3.1

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME LAKE KLARNEY
I.D. NUMBER 3[illegible]
SHEET NO. 3 OF 3
BY [illegible] DATE 6-[illegible]-79

OVERTOPPING PARAMETERS

DISCHARGE DETERMINED BY HEC-1.

TOP OF DAM ELEV. (SAME AS SPILLWAY CREST) = [illegible]
LENGTH = 35.5'
COEFFICIENT OF DISCHARGE = 3.0 (BROAD CRESTED).

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1          A1      ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
    2          A2      HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE KILLARNEY
    3          A3      RATIOS OF PMF ROUTED THROUGH THE RESERVOIR  (MISSOURI =300121
    4          B    192       0      15       0       0       0       0       0       0       0
    5          B1     5
    6          J      1       6       1
    7          J1    .1      .2      .3      .4      .5       1
    8          K      0       1                                       1
    9          K1       INFLOW TO RESERVOIR
   10          M      1       2      50                      50       1                               1
   11          P             26.0      86     104     114     124
   12          T                                                              -1      -87
   13          W2            2.0
   14          X    -1.5     -.05     2.0
   15          K      1       2                                               1
   16          K1       ROUTE THROUGH RESERVOIR
   17          Y                                       1       1
   18          Y1     1                                                       -808
   19          SA     0      60      80      90     105     193
   20          SE   749     808     812     815     820     840
   21          SS   808     400     3.1     1.5
   22          SD   808     3.1     1.5    35.5
   23          K     99
```

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE 79/06/25.
TIME 08.38.46.

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE KILLARNEY
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR (MISSOURI =30012)

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
192	0	15	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1

RTIOS=	.10	.20	.30	.40	.50	1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	50.00	0.00	50.00	1.00	0.000	0	1	0

PRECIP DATA

SPEE	PMS	R6	R12	R24	R48	R72	R96
0.00	26.00	86.00	104.00	114.00	124.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-87.00	0.00	0.00

CURVE NO = -87.00 WETNESS = -1.00 EFFECT CN = 87.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= 2.00

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 42 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 2.00 VOL= 1.00

481.	1496.	2879.	4803.	7241.	9386.	10722.	11290.	11290.	10722.
9813.	8724.	7322.	5825.	4710.	3868.	3180.	2692.	2231.	1830.
1509.	1242.	1035.	845.	698.	575.	474.	395.	324.	271.
222.	182.	152.	125.	109.	93.	77.	61.	47.	33.
20.	.7.								

END-OF-PERIOD FLOW

0 MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.15	1	.00	0.00	.00	70.	1.02	.15	97	.04	.04	.01	805.
1.01	.30	2	.00	0.00	.00	65.	1.02	.30	98	.04	.04	.01	824.
1.01	.45	3	.00	0.00	.00	61.	1.02	.45	99	.04	.04	.01	891.
1.01	1.00	4	.00	0.00	.00	57.	1.02	1.00	100	.04	.04	.01	1023.
1.01	1.15	5	.00	0.00	.00	53.	1.02	1.15	101	.04	.04	.01	1237.
1.01	1.30	6	.00	0.00	.00	49.	1.02	1.30	102	.04	.04	.01	1522.
1.01	1.45	7	.00	0.00	.00	46.	1.02	1.45	103	.04	.04	.01	1854.

1.01	2.00	8	.00	0.00	.00	43.	1.02	2.00	104	.04	.04	.01	2207.
1.01	2.15	9	.00	0.00	.00	40.	1.02	2.15	105	.04	.04	.01	2565.
1.01	2.30	10	.00	0.00	.00	37.	1.02	2.30	106	.04	.04	.01	2909.
1.01	2.45	11	.00	0.00	.00	35.	1.02	2.45	107	.04	.04	.01	3227.
1.01	3.00	12	.00	0.00	.00	33.	1.02	3.00	108	.04	.04	.01	3512.
1.01	3.15	13	.00	0.00	.00	30.	1.02	3.15	109	.04	.04	.01	3754.
1.01	3.30	14	.00	0.00	.00	28.	1.02	3.30	110	.04	.04	.01	3949.
1.01	3.45	15	.00	0.00	.00	27.	1.02	3.45	111	.04	.04	.00	4110.
1.01	4.00	16	.00	0.00	.00	25.	1.02	4.00	112	.04	.04	.00	4245.
1.01	4.15	17	.00	0.00	.00	23.	1.02	4.15	113	.04	.04	.00	4359.
1.01	4.30	18	.00	0.00	.00	22.	1.02	4.30	114	.04	.04	.00	4458.
1.01	4.45	19	.00	0.00	.00	20.	1.02	4.45	115	.04	.04	.00	4543.
1.01	5.00	20	.00	0.00	.00	19.	1.02	5.00	116	.04	.04	.00	4614.
1.01	5.15	21	.00	0.00	.00	17.	1.02	5.15	117	.04	.04	.00	4675.
1.01	5.30	22	.00	0.00	.00	16.	1.02	5.30	118	.04	.04	.00	4728.
1.01	5.45	23	.00	0.00	.00	15.	1.02	5.45	119	.04	.04	.00	4774.
1.01	6.00	24	.00	0.00	.00	14.	1.02	6.00	120	.04	.04	.00	4813.
1.01	6.15	25	.02	0.00	.02	13.	1.02	6.15	121	.20	.18	.02	4914.
1.01	6.30	26	.02	0.00	.02	12.	1.02	6.30	122	.20	.18	.02	5151.
1.01	6.45	27	.02	0.00	.02	12.	1.02	6.45	123	.20	.18	.02	5577.
1.01	7.00	28	.02	0.00	.02	11.	1.02	7.00	124	.20	.18	.01	6269.
1.01	7.15	29	.02	0.00	.02	10.	1.02	7.15	125	.20	.18	.01	7301.
1.01	7.30	30	.02	0.00	.02	9.	1.02	7.30	126	.20	.18	.01	8633.
1.01	7.45	31	.02	0.00	.02	9.	1.02	7.45	127	.20	.18	.01	10158.
1.01	8.00	32	.02	0.00	.02	8.	1.02	8.00	128	.20	.18	.01	11770.
1.01	8.15	33	.02	0.00	.02	8.	1.02	8.15	129	.20	.18	.01	13391.
1.01	8.30	34	.02	0.00	.02	7.	1.02	8.30	130	.20	.19	.01	14941.
1.01	8.45	35	.02	0.00	.02	7.	1.02	8.45	131	.20	.19	.01	16373.
1.01	9.00	36	.02	0.00	.02	6.	1.02	9.00	132	.20	.19	.01	17660.
1.01	9.15	37	.02	.00	.02	6.	1.02	9.15	133	.20	.19	.01	18759.
1.01	9.30	38	.02	.00	.02	6.	1.02	9.30	134	.20	.19	.01	19646.
1.01	9.45	39	.02	.00	.02	7.	1.02	9.45	135	.20	.19	.01	20381.
1.01	10.00	40	.02	.00	.02	9.	1.02	10.00	136	.20	.19	.01	20999.
1.01	10.15	41	.02	.00	.02	13.	1.02	10.15	137	.20	.19	.01	21518.
1.01	10.30	42	.02	.00	.02	20.	1.02	10.30	138	.20	.19	.01	21966.
1.01	10.45	43	.02	.00	.01	31.	1.02	10.45	139	.20	.19	.01	22348.

1.01	11.00	44	.02	.00	.01	46.	1.02	11.00	140	.20	.19	.01	22670.
1.01	11.15	45	.02	.00	.01	64.	1.02	11.15	141	.20	.19	.01	22945.
1.01	11.30	46	.02	.00	.01	87.	1.02	11.30	142	.20	.19	.01	23179.
1.01	11.45	47	.02	.00	.01	112.	1.02	11.45	143	.20	.19	.01	23381.
1.01	12.00	48	.02	.00	.01	140.	1.02	12.00	144	.20	.19	.00	23553.
1.01	12.15	49	.05	.01	.04	175.	1.02	12.15	145	.56	.55	.01	23873.
1.01	12.30	50	.05	.01	.03	220.	1.02	12.30	146	.56	.55	.01	24534.
1.01	12.45	51	.05	.02	.03	280.	1.02	12.45	147	.56	.55	.01	25672.
1.01	13.00	52	.05	.02	.03	361.	1.02	13.00	148	.56	.55	.01	27484.
1.01	13.15	53	.06	.02	.04	472.	1.02	13.15	149	.67	.66	.01	30208.
1.01	13.30	54	.06	.03	.03	616.	1.02	13.30	150	.67	.66	.01	33804.
1.01	13.45	55	.06	.03	.03	792.	1.02	13.45	151	.67	.66	.01	38027.
1.01	14.00	56	.06	.03	.03	996.	1.02	14.00	152	.67	.66	.01	42667.
1.01	14.15	57	.07	.04	.04	1232.	1.02	14.15	153	.84	.83	.01	47657.
1.01	14.30	58	.07	.04	.03	1497.	1.02	14.30	154	.84	.83	.01	52853.
1.01	14.45	59	.07	.04	.03	1788.	1.02	14.45	155	.84	.83	.01	58107.
1.01	15.00	60	.07	.04	.03	2103.	1.02	15.00	156	.84	.83	.01	63358.
1.01	15.15	61	.07	.05	.03	2441.	1.02	15.15	157	.85	.84	.01	68521.
1.01	15.30	62	.15	.10	.05	2818.	1.02	15.30	158	1.70	1.69	.01	73869.
1.01	15.45	63	.42	.30	.11	3351.	1.02	15.45	159	4.76	4.74	.02	81267.
1.01	16.00	64	.10	.08	.02	4053.	1.02	16.00	160	1.19	1.19	.00	90918.
1.01	16.15	65	.07	.05	.01	4886.	1.02	16.15	161	.78	.78	.00	102230.
1.01	16.30	66	.07	.05	.01	5881.	1.02	16.30	162	.78	.78	.00	115728.
1.01	16.45	67	.07	.05	.01	6993.	1.02	16.45	163	.78	.78	.00	130645.
1.01	17.00	68	.07	.06	.01	7989.	1.02	17.00	164	.78	.78	.00	143370.
1.01	17.15	69	.05	.04	.01	8707.	1.02	17.15	165	.61	.61	.00	151530.
1.01	17.30	70	.05	.04	.01	9143.	1.02	17.30	166	.61	.61	.00	155226.
1.01	17.45	71	.05	.04	.01	9346.	1.02	17.45	167	.61	.61	.00	155324.
1.01	18.00	72	.05	.04	.01	9326.	1.02	18.00	168	.61	.61	.00	152102.
1.01	18.15	73	.01	.00	.00	9122.	1.02	18.15	169	.06	.06	.00	146313.
1.01	18.30	74	.01	.00	.00	8760.	1.02	18.30	170	.06	.06	.00	138385.
1.01	18.45	75	.01	.00	.00	8215.	1.02	18.45	171	.06	.06	.00	128018.
1.01	19.00	76	.01	.00	.00	7552.	1.02	19.00	172	.06	.06	.00	116292.
1.01	19.15	77	.01	.00	.00	6880.	1.02	19.15	173	.06	.06	.00	104895.
1.01	19.30	78	.01	.00	.00	6199.	1.02	19.30	174	.06	.06	.00	93753.
1.01	19.45	79	.01	.00	.00	5516.	1.02	19.45	175	.06	.06	.00	82893.

1.01	20.00	80	.01	.00	.00	4866.	1.02	20.00	176	.06	.06	.00	72750.
1.01	20.15	81	.01	.00	.00	4237.	1.02	20.15	177	.06	.06	.00	63058.
1.01	20.30	82	.01	.00	.00	3658.	1.02	20.30	178	.06	.06	.00	54232.
1.01	20.45	83	.01	.00	.00	3145.	1.02	20.45	179	.06	.06	.00	46467.
1.01	21.00	84	.01	.00	.00	2697.	1.02	21.00	180	.06	.06	.00	39725.
1.01	21.15	85	.01	.00	.00	2325.	1.02	21.15	181	.06	.06	.00	34133.
1.01	21.30	86	.01	.00	.00	2022.	1.02	21.30	182	.06	.06	.00	29564.
1.01	21.45	87	.01	.00	.00	1777.	1.02	21.45	183	.06	.06	.00	25874.
1.01	22.00	88	.01	.00	.00	1576.	1.02	22.00	184	.06	.06	.00	22835.
1.01	22.15	89	.01	.00	.00	1412.	1.02	22.15	185	.06	.06	.00	20341.
1.01	22.30	90	.01	.00	.00	1274.	1.02	22.30	186	.06	.06	.00	18253.
1.01	22.45	91	.01	.00	.00	1158.	1.02	22.45	187	.06	.06	.00	16502.
1.01	23.00	92	.01	.00	.00	1064.	1.02	23.00	188	.06	.06	.00	15081.
1.01	23.15	93	.01	.00	.00	986.	1.02	23.15	189	.06	.06	.00	13894.
1.01	23.30	94	.01	.00	.00	921.	1.02	23.30	190	.06	.06	.00	12914.
1.01	23.45	95	.01	.00	.00	868.	1.02	23.45	191	.06	.06	.00	12106.
1.02	0.00	96	.01	.00	.00	825.	1.03	0.00	192	.06	.06	.00	11444.
									SUM	32.24	30.51	1.73	3841786.
										(819.)(	775.)(	44.)(	********)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	155324.	105920.	38151.	19979.	3836030.
CMS	4398.	2999.	1080.	566.	108624.
INCHES		19.71	28.39	29.74	29.74
MM		500.54	721.14	755.31	755.31
AC-FT		52523.	75671.	79257.	79257.
THOUS CU M		64786.	93338.	97762.	97762.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

7.	7.	6.	6.	5.	5.	5.	4.	4.	4.
3.	3.	3.	3.	3.	2.	2.	2.	2.	2.
2.	2.	2.	1.	1.	1.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	77662.	52960.	19075.	9990.	1918015.
CMS	2199.	1500.	540.	283.	54312.
INCHES		9.85	14.20	14.87	14.87
MM		250.27	360.57	377.66	377.66
AC-FT		26261.	37835.	39628.	39628.
THOUS CU M		32393.	46669.	48881.	48881.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 6

70.	65.	61.	57.	53.	49.	46.	43.	40.	37.
35.	33.	30.	28.	27.	25.	23.	22.	20.	19.
17.	16.	15.	14.	13.	12.	12.	11.	10.	9.
9.	8.	8.	7.	7.	6.	6.	6.	7.	9.
13.	20.	31.	46.	64.	87.	112.	140.	175.	220.
280.	361.	472.	616.	792.	996.	1232.	1497.	1788.	2103.
2441.	2818.	3351.	4053.	4886.	5881.	6993.	7989.	8707.	9143.
9346.	9326.	9122.	8760.	8215.	7552.	6880.	6199.	5516.	4866.
4237.	3658.	3145.	2697.	2325.	2022.	1777.	1576.	1412.	1274.
1158.	1064.	986.	921.	868.	825.	805.	824.	891.	1023.
1237.	1522.	1854.	2207.	2565.	2909.	3227.	3512.	3754.	3949.
4110.	4245.	4359.	4458.	4543.	4614.	4675.	4728.	4774.	4813.
4914.	5151.	5577.	6269.	7301.	8633.	10158.	11770.	13391.	14941.
16373.	17660.	18755.	19646.	20381.	20999.	21518.	21966.	22348.	22670.
22945.	23179.	23381.	23553.	23873.	24534.	25672.	27484.	30208.	33804.
38027.	42667.	47657.	52853.	58107.	63358.	68521.	73863.	81267.	90918.
102230.	115728.	130645.	143370.	151530.	155226.	155324.	152102.	146313.	138385.
128018.	116292.	104895.	93753.	82893.	72750.	63058.	54232.	46467.	39725.
34133.	29564.	25874.	22835.	20341.	18253.	16502.	15081.	13894.	12914.
12106.	11444.								

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	155324.	105920.	38151.	19979.	3836030.
CMS	4398.	2999.	1080.	566.	108624.

INCHES	19.71	28.39	29.74	29.74
MM	500.54	721.14	755.31	755.31
AC-FT	52523.	75671.	79257.	79257.
THOUS CU M	64786.	93338.	97762.	97762.

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HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-808.	0

SURFACE AREA=	0.	60.	80.	90.	105.	193.
CAPACITY=	0.	1180.	1459.	1714.	2201.	5137.
ELEVATION=	749.	808.	812.	815.	820.	840.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
808.0	400.0	3.1	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
808.0	3.1	1.5	36.

813.5	813.9	814.4	814.9	815.4	815.8	816.3	816.7	817.2	817.9
818.7	819.6	820.6	821.5	822.2	822.7	822.9	822.8	822.6	822.2
821.6	820.9	820.1	819.2	818.4	817.6	816.8	816.0	815.3	814.6
813.9	813.4	812.9	812.5	812.2	811.9	811.6	811.4	811.2	811.0
810.9	810.7								

PEAK OUTFLOW IS 77332. AT TIME 41.75 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	77332.	52871.	18999.	9944.	1909206.
CMS	2190.	1497.	538.	282.	54063.
INCHES		9.84	14.14	14.80	14.80
MM		249.84	359.12	375.92	375.92
AC-FT		26217.	37683.	39446.	39446.
THOUS CU M		32338.	46482.	48656.	48656.

STATION 2. PLAN 1. RATIO 6

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

5.	12.	19.	25.	30.	34.	37.	38.	39.	39.
38.	37.	36.	35.	34.	32.	31.	29.	28.	26.
25.	24.	22.	21.	20.	19.	18.	17.	16.	15.
14.	13.	13.	12.	11.	11.	10.	10.	9.	9.
9.	10.	12.	16.	22.	31.	43.	60.	82.	110.
148.	199.	268.	363.	490.	652.	849.	1083.	1350.	1647.
1972.	2325.	2746.	3293.	3989.	4840.	5844.	6906.	7854.	8567.
9022.	9233.	9227.	9034.	8667.	8144.	7529.	6881.	6219.	5564.
4929.	4325.	3769.	3270.	2835.	2465.	2157.	1902.	1690.	1514.
1366.	1243.	1140.	1054.	981.	921.	874.	848.	852.	898.
1002.	1178.	1425.	1731.	2074.	2434.	2787.	3119.	3417.	3672.
3884.	4060.	4206.	4329.	4433.	4522.	4597.	4661.	4716.	4764.

4825.	4953.	5209.	5659.	6379.	7414.	8731.	10243.	11854.	13479.
15036.	16468.	17739.	18815.	19703.	20437.	21050.	21568.	22010.	22389.
22703.	22974.	23205.	23403.	23637.	24066.	24854.	26170.	28227.	31159.
34888.	39214.	43973.	49042.	54274.	59550.	64781.	70036.	76212.	84316.
94360.	106308.	120045.	133775.	144783.	151672.	154552.	153882.	150143.	143892.
135288.	124672.	113239.	101892.	90791.	80158.	70106.	60715.	52253.	44843.
38510.	33247.	28938.	25415.	22513.	20103.	18086.	16408.	15019.	13864.
12905.	12112.								

STORAGE

1181.	1183.	1184.	1184.	1185.	1185.	1185.	1186.	1186.	1186.
1186.	1186.	1185.	1186.	1185.	1185.	1185.	1185.	1185.	1184.
1184.	1184.	1184.	1184.	1184.	1184.	1183.	1183.	1183.	1183.
1183.	1183.	1183.	1183.	1182.	1182.	1182.	1182.	1182.	1182.
1182.	1182.	1183.	1183.	1184.	1185.	1186.	1188.	1189.	1191.
1194.	1197.	1201.	1205.	1211.	1218.	1225.	1234.	1242.	1252.
1261.	1271.	1282.	1297.	1314.	1334.	1356.	1379.	1399.	1414.
1423.	1428.	1428.	1424.	1416.	1405.	1393.	1379.	1365.	1350.
1336.	1322.	1308.	1296.	1285.	1275.	1266.	1259.	1253.	1248.
1243.	1239.	1235.	1233.	1230.	1228.	1226.	1225.	1225.	1227.
1231.	1237.	1245.	1254.	1264.	1274.	1284.	1292.	1300.	1306.
1311.	1315.	1319.	1322.	1324.	1326.	1328.	1330.	1331.	1332.
1333.	1336.	1342.	1352.	1368.	1390.	1417.	1448.	1480.	1511.
1540.	1566.	1589.	1608.	1623.	1636.	1647.	1656.	1663.	1670.
1679.	1680.	1684.	1687.	1691.	1698.	1711.	1733.	1767.	1815.
1875.	1943.	2017.	2094.	2173.	2252.	2330.	2408.	2500.	2620.
2770.	2949.	3155.	3364.	3533.	3639.	3684.	3674.	3616.	3519.
3387.	3225.	3053.	2882.	2717.	2559.	2409.	2270.	2143.	2030.
1932.	1849.	1779.	1721.	1672.	1630.	1595.	1565.	1539.	1518.
1500.	1489.								

STAGE

808.0	808.0	808.1	808.1	808.1	808.1	808.1	808.1	808.1	808.1
808.1	808.1	808.1	808.1	808.1	808.1	808.1	808.1	808.1	808.1
808.1	808.1	808.1	808.1	808.1	808.1	808.1	808.1	808.1	808.1
808.0	808.0	808.0	808.0	808.0	808.0	808.0	808.0	808.0	808.0

808.0	808.0	808.0	808.1	808.1	808.1	808.1	808.1	808.2	808.2
808.2	808.3	808.3	808.4	808.5	808.6	808.7	808.9	809.0	809.1
809.3	809.4	809.6	809.8	810.1	810.3	810.7	811.0	811.2	811.4
811.5	811.6	811.6	811.6	811.5	811.3	811.1	811.0	810.8	810.6
810.4	810.2	810.0	809.8	809.6	809.5	809.4	809.3	809.2	809.1
809.0	808.9	808.9	808.8	808.8	808.8	808.7	808.7	808.7	808.8
808.8	808.9	809.0	809.2	809.3	809.5	809.6	809.7	809.9	809.9
810.0	810.1	810.1	810.2	810.2	810.2	810.3	810.3	810.3	810.3
810.3	810.4	810.5	810.6	810.8	811.1	811.5	811.9	812.3	812.6
813.0	813.3	813.6	813.8	814.0	814.1	814.2	814.3	814.4	814.5
814.6	814.6	814.7	814.7	814.7	814.8	815.0	815.2	815.6	816.1
816.7	817.4	818.2	819.0	819.7	820.5	821.2	821.9	822.7	823.7
825.0	826.4	827.9	829.4	830.6	831.3	831.6	831.5	831.1	830.5
829.6	828.4	827.2	825.9	824.9	823.2	821.9	820.6	819.4	818.3
817.3	816.5	815.7	815.1	814.5	814.1	813.6	813.3	813.0	812.7
812.5	812.3								

PEAK OUTFLOW IS 154552. AT TIME 41.75 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	154552.	105768.	38021.	19903.	3821329.
CMS	4376.	2995.	1077.	564.	108208.
INCHES		19.68	28.29	29.62	29.62
MM		499.81	718.69	752.42	752.42
AC-FT		52447.	75414.	78953.	78953.
THOUS CU M		64692.	93021.	97387.	97387.

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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS					
				RATIO 1 .10	RATIO 2 .20	RATIO 3 .30	RATIO 4 .40	RATIO 5 .50	RATIO 6 1.00
HYDROGRAPH AT	1	50.00 (129.50)	1	15532. (439.83)(	31065. 879.66)(	46597. 1319.49)(	62130. 1759.32)(	77662. 2199.15)(	155324. 4398.29)(
ROUTED TO	2	50.00 (129.50)	1	15389. (435.78)(	30878. 874.36)(	46372. 1313.12)(	61860. 1751.69)(	77332. 2189.80)(	154552. 4376.44)(

SUMMARY OF DAM SAFETY ANALYSIS

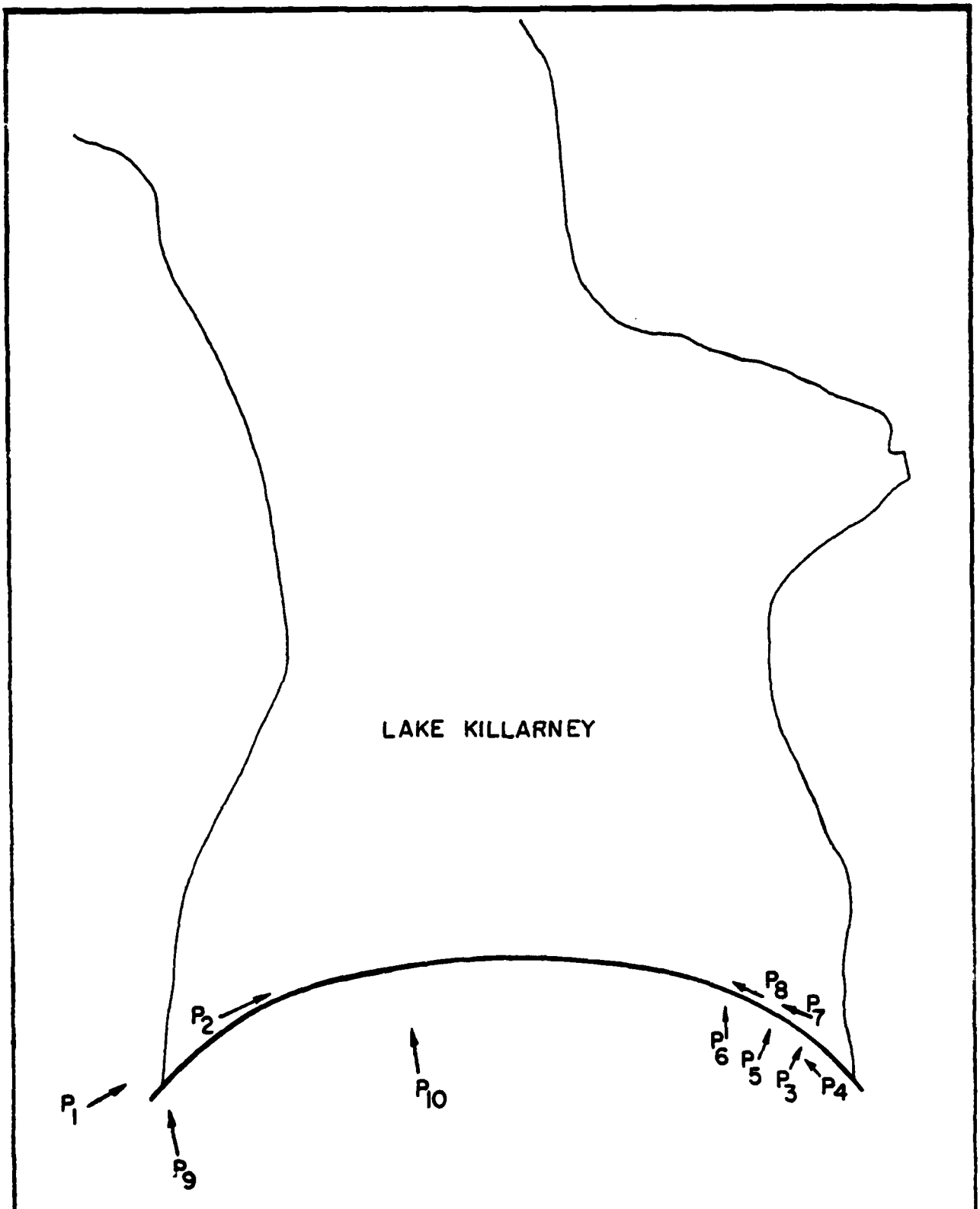
PLAN 1 ••••••••••••••••

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	808.00	808.00	808.00
STORAGE	1180.	1180.	1180.
OUTFLOW	0.	0.	0.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	813.06	5.06	1546.	15389.	48.00	41.75	0.00
.20	816.06	8.06	1811.	30878.	48.00	41.75	0.00
.30	818.57	10.57	2054.	46372.	48.00	41.75	0.00
.40	820.80	12.80	2287.	61860.	48.00	41.75	0.00
.50	822.86	14.86	2517.	77332.	48.00	41.75	0.00
1.00	831.58	23.58	3684.	154552.	48.00	41.75	0.00

APPENDIX C

PHOTOGRAPHS



P-INDICATES PHOTO LOCATION

LAKE KILLARNEY DAM
PHOTO INDEX

Photograph No. 1

Dam from right abutment.

Photograph No. 2

Left abutment of dam.

Photograph No. 3

Deteriorated concrete at left abutment.

Photograph No. 4

Vegetation and deteriorated concrete near left abutment.

Photograph No. 5

Close-up of vegetation and seepage near left abutment.

Photograph No. 6

Close-up of concrete.

Photograph No. 7

Crest of Dam.

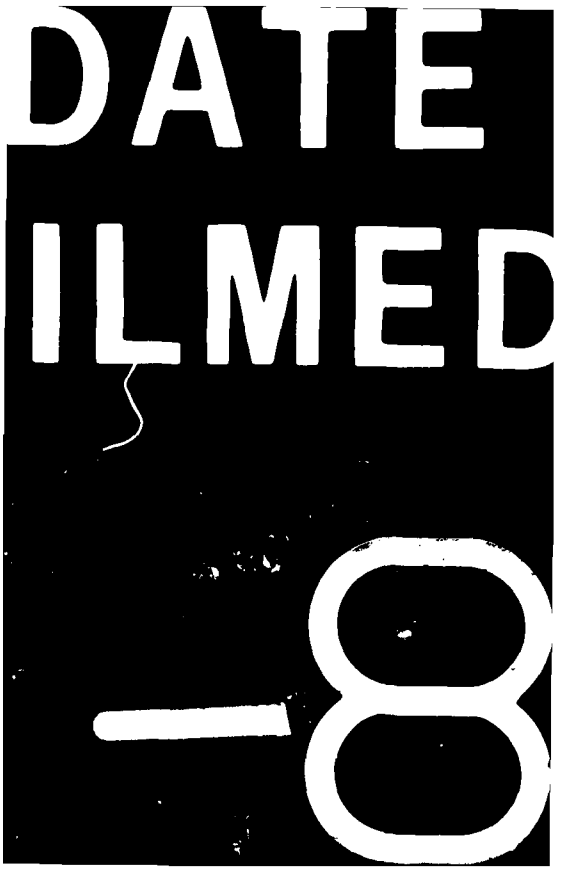
Photograph No. 8
Right abutment - Note erosion of soil.

Photograph No. 9

Right abutment - Note stone wall and soil abutment.

Photograph No. 10

Outlet works - Note crossbedding nature of concrete.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